

What is claimed is:

1 \1. An interconnect structure, comprising:

2 a lower level wire having a side and a bottom, said  
3 lower level wire comprising a lower core conductor and a  
4 lower conductive liner, said lower conductive liner on the  
5 side and the bottom of said lower level wire;

6 an upper level wire having a side and a bottom, said  
7 upper level wire comprising an upper core conductor and an  
8 upper conductive liner, said upper conductive liner on the  
9 side and the bottom of said upper level wire; and

10 said upper conductive liner in contact with said lower  
11 core conductor and also in contact with said lower  
12 conductive liner in a liner-to-liner contact region.

1 2. The interconnect structure of claim 1, wherein said  
2 lower level wire is formed by a damascene process in a lower  
3 level dielectric and said upper level wire is formed by a  
4 damascene process in an upper level dielectric.

1 3. The interconnect structure of claim 1, wherein said  
2 upper and lower core conductors are selected from the group

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3 consisting of copper, aluminum, aluminum-copper and  
4 aluminum-copper-silicon.

1 4. The interconnect structure of claim 1, wherein said  
2 upper and lower conductive liners are selected from the  
3 group consisting of tantalum, tantalum nitride, titanium,  
4 titanium nitride, tungsten and combinations thereof.

1 5. The interconnect structure of claim 1, wherein said  
2 lower conductive liner includes an upper edge having an  
3 inner surface, an outer surface, and a top surface and said  
4 upper conductive liner contacts one or more of said inner,  
5 outer and top surfaces to form said liner-to-liner contact  
6 region.

1 6. The interconnect structure of claim 1, wherein said  
2 liner-to liner contact region comprises a first portion co-  
3 extensive with said lower conductive liner on a portion of a  
4 first side of said lower level wire under said upper level  
5 wire.

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1        7. The interconnect structure of claim 6, wherein said  
2 liner-to liner contact region further comprises a second  
3 portion co-extensive with said lower conductive liner on a  
4 portion of a second side of said lower level wire under said  
5 upper level wire.

1        8. The interconnect structure of claim 7, wherein said  
2 liner-to-liner contact region further comprises a third  
3 portion co-extensive with said lower conductive liner on an  
4 end of said lower level wire under said upper level wire.

1        9. The interconnect structure of claim 2, wherein said  
2 first and second dielectrics are selected from the group  
3 consisting of silicon oxide, silicon nitride, diamond,  
4 fluorine doped silicon oxide, spin on glass, porous silicon  
5 oxide, polyimide, polyimide siloxane, polysilsequioxane  
6 polymer, benzocyclobutene, paralyene N, paralyene F,  
7 polyolefin, poly-naphthalene, amorphous Teflon, SILK™,  
8 black diamond, polymer foam, aerogel, air, dielectric gases,  
9 a partial vacuum and combinations thereof.

1     10. An interconnect structure, comprising:

2         a lower level wire having a side and a bottom, said  
3 lower level wire comprising a lower core conductor and an  
4 lower conductive liner, said lower conductive liner on the  
5 side and the bottom of said lower level wire;

6         an upper level wire having a side and a bottom and a  
7 via integrally formed in the bottom of said upper level  
8 wire, said via have a side and a bottom, said upper level  
9 wire and said via each comprising an upper core conductor  
10 and an upper conductive liner, said upper conductive liner  
11 on the side and the bottom of said upper level wire and on  
12 the side and bottom of said via and  
13         said upper conductive liner on the bottom of said via  
14 in contact with said lower core conductor and also in  
15 contact with said lower conductive liner in a liner-to-liner  
16 contact region.

1         11. The interconnect structure of claim 10, wherein

2 said lower level wire is formed by a damascene or dual  
3 damascene process in a lower level dielectric and said upper  
4 level wire is formed by a dual-damascene process in an upper  
5 level dielectric.

1        12. The interconnect structure of claim 10, wherein  
2 said upper and lower core conductors are selected from the  
3 group consisting of copper, aluminum, aluminum-copper and  
4 aluminum-copper-silicon.

1        13. The interconnect structure of claim 10, wherein  
2 said upper and lower conductive liners are selected from the  
3 group consisting of tantalum, tantalum nitride, titanium,  
4 titanium nitride, tungsten and combinations thereof.

1        14. The interconnect structure of claim 10, wherein  
2 said lower conductive liner includes an upper edge having an  
3 inner surface, an outer surface, and a top surface and said  
4 upper conductive liner on the bottom of said via contacts  
5 one or more of said inner, outer and top surfaces to form  
6 said liner-to-liner contact region.

1        15. The interconnect structure of claim 10, wherein  
2 said liner-to liner contact region comprises a first portion  
3 co-extensive with said lower conductive liner on a portion  
4 of a first side of said lower level wire under said via.

1 16. The interconnect structure of claim 15, wherein  
2 said liner-to liner contact region further comprises a  
3 second portion co-extensive with said lower conductive liner  
4 on a portion of a second side of said lower level wire under  
5 said via.

1 17. The interconnect structure of claim 16, wherein  
2 said liner-to-liner contact region further comprises a third  
3 portion co-extensive with said lower conductive liner on an  
4 end of said lower level wire under said via.

1 18. The interconnect structure of claim 10, wherein  
2 said liner-to liner contact region comprises a first portion  
3 co-extensive with said lower conductive liner on a portion  
4 of a first side of said lower level wire under said via and  
5 a second portion co-extensive with said lower conductive  
6 liner on a portion of an end of said lower level wire under  
7 said via.

1 19. The interconnect structure of claim 11, wherein  
2 said first and second dielectrics are selected from the  
3 group consisting of silicon oxide, silicon nitride, diamond,

4 fluorine doped silicon oxide, spin on glass, porous silicon  
5 oxide, polyimide, polyimide siloxane, polysilsequioxane  
6 polymer, benzocyclobutene, paralyene N, paralyene F,  
7 polyolefin, poly-naphthalene, amorphous Teflon, SILK™,  
8 black diamond, polymer foam, aerogel, air, dielectric gases,  
9 a partial vacuum and combinations thereof.

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1        20. An interconnect structure, comprising:

2        a lower level wire having a side and a bottom, said  
3 lower level wire comprising a lower core conductor and an  
4 lower conductive liner, said lower conductive liner on the  
5 side and the bottom of said lower level wire;

6        an upper level wire having a side and a bottom and an  
7 array of vias integrally formed in the bottom of said upper  
8 level wire, each via of said array of vias having a side and  
9 a bottom, said upper level wire and each via comprising an  
10 upper core conductor and an upper conductive liner, said  
11 upper conductive liner on the side and the bottom of said  
12 upper level wire and on the side and bottom of each via; and  
13        said upper conductive liner on the bottom of each via  
14 of a first portion of said array of vias in contact with  
15 said lower core conductor and each via of a second portion  
16 of said array of vias in contact with said lower core  
17 conductor and also in contact with said lower conductive  
18 liner in liner-to-liner contact regions.

1        21. The interconnect structure of claim 20, wherein  
2 said lower conductive liner includes an upper edge having an  
3 inner surface, an outer surface, and a top surface and said



4 upper conductive liner on the bottom of vias of said second  
5 portion of said array of vias contact one or more of said  
6 inner, outer and top surfaces to form said liner-to-liner  
7 contact region.

1 22. The interconnect structure of claim 20, wherein  
2 said liner-to liner contact region comprises first portions  
3 co-extensive with said lower conductive liner on portions of  
4 first sides of said lower level wire under vias of said  
5 second portion of said array of vias.

1 23. The interconnect structure of claim 22, wherein  
2 said liner-to liner contact region further comprises second  
3 portions co-extensive with said lower conductive liner on  
4 portions of second sides of said lower level wire under vias  
5 of said second portion of said array of vias.

1 24. The interconnect structure of claim 23, wherein  
2 said liner-to-liner contact region further comprises a third  
3 portion co-extensive with said lower conductive liner on an  
4 end of said lower level wire under vias of said second  
5 portion of said array of vias.

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1        25. An interconnect structure, comprising:  
2            a lower level wire having a side and a bottom and one  
3        or more integral extensions each extension having a side and  
4        a bottom , said lower level wire and extensions comprising a  
5        lower core conductor and an lower conductive liner, said  
6        lower conductive liner on the side and the bottom of said  
7        lower level wire and said extensions;  
8            an upper level wire having a side and a bottom and an  
9        array of vias integrally formed in the bottom of said upper  
10       level wire, each via of said array of vias having a side and  
11       a bottom, said upper level wire and each via comprising an  
12       upper core conductor and an upper conductive liner, said  
13       upper conductive liner on the side and the bottom of said  
14       upper level wire and on the side and bottom of each via; and  
15            said upper conductive liner on the bottom of each said  
16       via of a first portion of said array of vias in contact with  
17       said lower core conductor of said lower level wire and a  
18       second portion of said array of vias in contact with said  
19       lower core conductor of said extensions and also in contact  
20       with said lower conductive liner of said extensions in  
21       liner-to-liner contact regions.

1        26. The interconnect structure of claim 25, wherein  
2        said lower conductive liner on said extension includes an  
3        upper edge having an inner surface, an outer surface, and a  
4        top surface and said upper conductive liner on the bottom of  
5        vias of said second portion of said array of vias contact  
6        one or more of said inner, outer and top surfaces to form  
7        said liner-to-liner contact region.

1        27. The interconnect structure of claim 25, wherein  
2        said liner-to liner contact region comprises first portions  
3        co-extensive with said lower conductive liner on portions of  
4        first sides of said extensions of said lower level wire  
5        under vias of said second portion of said array of vias.

1        28. The interconnect structure of claim 27, wherein  
2        said liner-to liner contact region further comprises second  
3        portions co-extensive with said lower conductive liner on  
4        portions of second sides of said extensions of said lower  
5        level wire under vias of said second portion of said array  
6        of vias.

1        29. The interconnect structure of claim 28, wherein  
2        said liner-to-liner contact region further comprises a third  
3        portion co-extensive with said lower conductive liner on an  
4        end of said lower level wire under vias of said second  
5        portion of said array of vias.

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1        31. An interconnect structure, comprising:  
2        a lower level wire having a side and a bottom, said  
3        lower level wire comprising a lower core conductor and an  
4        lower conductive liner, said lower conductive liner on the  
5        side and the bottom of said lower level wire;  
6        one or more dielectric pillars formed in said lower  
7        level wire, said lower conductive liner on sides of said  
8        dielectric pillars;  
9        an upper level wire having a side and a bottom and one  
10       or more vias integrally formed in the bottom of said upper  
11       level wire, each via having a side and a bottom, said upper  
12       level wire and each via comprising an upper core conductor  
13       and an upper conductive liner, said upper conductive liner  
14       on the side and the bottom of said upper level wire and on  
15       the side and bottom of each via; and  
16       said upper conductive liner on the bottom of at least a  
17       portion of said one or more vias in contact with said lower  
18       core conductor and at least a portion of said one or more  
19       vias in contact with said lower conductive liner on said  
20       side of at least a portion of said one or more dielectric  
21       pillars in liner-to-liner contact regions.

1        32. The interconnect structure of claim 31, wherein  
2 said lower conductive liner on the side of said one or more  
3 dielectric pillars includes an upper edge having an inner  
4 surface, an outer surface, and a top surface and said upper  
5 conductive liner on the bottom of vias of said second  
6 portion of said array of vias contact one or more of said  
7 inner, outer and top surfaces to form said liner-to-liner  
8 contact region.

1        33. The interconnect structure of claim 31, wherein  
2 said liner-to liner contact region comprises first portions  
3 co-extensive with said lower conductive liner on portions of  
4 first sides of said dielectric pillars under said vias.

1        34. The interconnect structure of claim 33, wherein  
2 said liner-to liner contact region further comprises second  
3 portions co-extensive with said lower conductive liner on  
4 portions of second sides of said dielectric pillars under  
5 said vias.

1        35. The interconnect structure of claim 34, wherein  
2 said liner-to-liner contact region further comprises a third

3 portion co-extensive with said lower conductive liner on  
4 portions of third sides of said dielectric pillars under  
5 said vias.

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1        36. A method of fabricating an interconnect structure,  
2 comprising:  
3        providing a substrate;  
4        forming, on said substrate, a lower level wire having a  
5 side and a bottom, said lower level wire comprising a lower  
6 core conductor and a lower conductive liner, said lower  
7 conductive liner formed on the side and the bottom of said  
8 lower level wire;  
9        forming an upper level wire having a side and a bottom,  
10 said upper level wire comprising an upper core conductor  
11 and an upper conductive liner, said upper conductive liner  
12 formed on the side and the bottom of said upper level wire;  
13 and  
14        aligning said lower level wire with said upper level  
15 wire such that said upper conductive liner contacts said  
16 lower core conductor and also contacts said lower conductive  
17 liner to form a liner-to-liner contact region.

1           37. The method of claim 36, wherein said lower level  
2 wire is formed by a damascene process in a lower level  
3 dielectric layer and said upper level wire is formed by a  
4 damascene process in an upper level dielectric layer.

1        38. The method of claim 36, wherein said upper and  
2 lower core conductors are selected from the group consisting  
3 of copper, aluminum, aluminum-copper and aluminum-copper-  
4 silicon.

1        39. The method of claim 36, wherein said upper and  
2 lower conductive liners are selected from the group  
3 consisting of tantalum, tantalum nitride, titanium, titanium  
4 nitride, tungsten and combinations thereof.

1        40. The method of claim 37, wherein said first and  
2 second dielectrics are selected from the group consisting of  
3 silicon oxide, silicon nitride, diamond, fluorine doped  
4 silicon oxide, spin on glass, porous silicon oxide,  
5 polyimide, polyimide siloxane, polysilsequioxane polymer,  
6 benzocyclobutene, paralyene N, paralyene F, polyolefin,  
7 poly-naphthalene, amorphous Teflon, SILK™, black diamond,  
8 polymer foam, aerogel, air, dielectric gases, a partial  
9 vacuum and combinations thereof.

1 41. A method of fabricating an interconnect structure,  
2 comprising:  
3 providing a substrate;  
4 forming, on said substrate, a lower level wire having a  
5 side and a bottom, said lower level wire comprising a lower  
6 core conductor and an lower conductive liner, said lower  
7 conductive liner formed on the side and the bottom of said  
8 lower level wire in a lower dielectric layer;  
9 forming an upper level wire having a side and a bottom  
10 and a via integrally formed in the bottom of said upper  
11 level wire, said via having a side and a bottom, said upper  
12 level wire and said via each comprising an upper core  
13 conductor and an upper conductive liner, said upper  
14 conductive liner formed on the side and the bottom of said  
15 upper level wire and on the side and bottom of said via; and  
16 aligning upper level wire with said lower level wire  
17 such that said upper conductive liner on the bottom of said  
18 via contacts said lower core conductor and also contacts  
19 said lower conductive liner to form a liner-to-liner contact  
20 region.

1        42. The method of claim 41, wherein said lower level  
2 wire is formed by a damascene process in a lower level  
3 dielectric layer and said upper level wire is formed by a  
4 damascene process in an upper level dielectric layer.

1        43. The method of claim 41, wherein said upper and  
2 lower core conductors are selected from the group consisting  
3 of copper, aluminum, aluminum-copper and aluminum-copper-  
4 silicon.

1        44. The method of claim 41, wherein said upper and  
2 lower conductive liners are selected from the group  
3 consisting of tantalum, tantalum nitride, titanium, titanium  
4 nitride, tungsten and combinations thereof.

1        45. The method of claim 41, wherein said first and  
2 second dielectrics are selected from the group consisting of  
3 silicon oxide, silicon nitride, diamond, fluorine doped  
4 silicon oxide, spin on glass, porous silicon oxide,  
5 polyimide, polyimide siloxane, polysilsequioxane polymer,  
6 benzocyclobutene, paralyene N, paralyene F, polyolefin,  
7 poly-naphthalene, amorphous Teflon, SILK™, black diamond,

- 8 polymer foam, aerogel, air, dielectric gases, a partial  
9 vacuum and combinations thereof.

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1        46. A method of forming an interconnect structure,  
2 comprising:  
3        providing a substrate;  
4        forming, on said substrate, a lower level wire having a  
5 side and a bottom, said lower level wire comprising a lower  
6 core conductor and a lower conductive liner, said lower  
7 conductive liner formed on the side and the bottom of said  
8 lower level wire;  
9        forming one or more dielectric pillars in said lower  
10 level wire, said lower conductive liner formed on sides of  
11 said dielectric pillars;  
12        forming an upper level wire having a side and a bottom,  
13 said upper level wire comprising an upper core conductor  
14 and an upper conductive liner, said upper conductive liner  
15 formed on the side and the bottom of said upper level wire;  
16 and  
17        aligning said upper level wire with said lower level  
18 wire such that said upper conductive liner contacts said  
19 lower core conductor and also contacts said lower conductive  
20 liner on the sides of said dielectric pillars to form liner-  
21 to-liner contact regions.

1 47. A method of fabricating an interconnect structure,  
2 comprising:  
3 providing a substrate;  
4 forming, on said substrate, a lower level wire having a  
5 side and a bottom, said lower level wire comprising a lower  
6 core conductor and an lower conductive liner, said lower  
7 conductive liner formed on the side and the bottom of said  
8 lower level wire;  
9 forming one or more dielectric pillars in said lower  
10 level wire, said lower conductive liner formed on sides of  
11 said dielectric pillars;  
12 forming an upper level wire having a side and a bottom  
13 and one or more vias integrally formed in the bottom of said  
14 upper level wire, each via having a side and a bottom, said  
15 upper level wire and each via comprising an upper core  
16 conductor and an upper conductive liner, said upper  
17 conductive liner formed on the side and the bottom of said  
18 upper level wire and on the side and bottom of each via; and  
19 aligning said upper level wire to said lower level wire  
20 such that said upper conductive liner on the bottom of at  
21 least a portion of said one or more vias contacts said lower  
22 core conductor and at least a portion of said one or more

23 vias contacts said lower conductive liner on said side of at  
24 least a portion of said one or more dielectric pillars to  
25 form liner-to-liner contact regions.

1 48. The method of claim 47, wherein said lower level  
2 wire is formed by a damascene process in a lower level  
3 dielectric layer and said upper level wire is formed by a  
4 dual-damascene process in an upper level dielectric layer.

1 49. The method of claim 47, wherein said upper and  
2 lower core conductors are selected from the group consisting  
3 of copper, aluminum, aluminum-copper and aluminum-copper-  
4 silicon.

1 50. The method of claim 47, wherein said upper and  
2 lower conductive liners are selected from the group  
3 consisting of tantalum, tantalum nitride, titanium, titanium  
4 nitride, tungsten and combinations thereof.

1 51. The method of claim 47, wherein dielectric pillars  
2 are formed from material selected from the group consisting  
3 of silicon oxide, silicon nitride, diamond, fluorine doped



4 silicon oxide, spin on glass, porous silicon oxide,  
5 polyimide, polyimide siloxane, polysilsequioxane polymer,  
6 benzocyclobutene, paralyene N, paralyene F, polyolefin,  
7 poly-naphthalene, amorphous Teflon, SILK™, black diamond,  
8 polymer foam, aerogel, air, dielectric gases, a partial  
9 vacuum and combinations thereof.

1 52. The method of claim 48, wherein said first and  
2 second dielectrics are selected from the group consisting of  
3 silicon oxide, silicon nitride, diamond, fluorine doped  
4 silicon oxide, spin on glass, porous silicon oxide,  
5 polyimide, polyimide siloxane, polysilsequioxane polymer,  
6 benzocyclobutene, paralyene N, paralyene F, polyolefin,  
7 poly-naphthalene, amorphous Teflon, SILK™, black diamond,  
8 polymer foam, aerogel, air, dielectric gases, a partial  
9 vacuum and combinations thereof.